MATS3001

Micromechanisms of Mechanical Behaviour in Metals

Course Outline
Session 1, 2016
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Course staff

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Course Objective

To relate dislocation theory and strengthening mechanisms to the mechanical behaviour of materials. These principles will be illustrated with respect to commercial aluminium, titanium and nickel alloys.
## Your Course at a Glance

<table>
<thead>
<tr>
<th>What you will learn</th>
<th>Weeks</th>
<th>Assessment task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revision of crystallography, defects in crystals</td>
<td>1</td>
<td>Online quiz Assignment 1</td>
</tr>
<tr>
<td>Properties of dislocations, Burgers vector, resolved shear stresses and dislocation motion, slip, elastic and energetic properties of dislocations, climb and cross-slip, dislocation interactions, origin and multiplication of dislocations</td>
<td>2-4</td>
<td></td>
</tr>
<tr>
<td>Dislocations in fcc, hcp, and bcc crystals</td>
<td>4-5</td>
<td></td>
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</tbody>
</table>

### Assignment 1 due Week 5
- Dislocations in covalent and ionic crystals                                   | 6     |                                     |

### Midsession exam Week 7 – Monday, 18 April 2016
- Strengthening mechanisms, strain hardening, grain size strengthening          | 7     | Assignment 2                       |
- ANZAC DAY HOLIDAY, Monday April 25th                                          | 8     |                                     |
- Solid solution hardening                                                       | 9-10  |                                     |
- Yield point effects, Age-hardening, dispersion hardening                      | 11-12 |                                     |
- High temperature deformation; creep; stress relaxation; effect of strain rate and temperature | 11-12 |                                     |

### Assignment 2
- Presentations on Commercial Al, Ni and Ti alloys.                             | 12    |                                     |
- Revision of main topics                                                       |       |                                     |

### Final exam

## Timetable

### Lectures

<table>
<thead>
<tr>
<th>Day</th>
<th>Time</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>15:00 – 17:00</td>
<td>Ainsworth Bldg J17-202</td>
</tr>
<tr>
<td>Thursday (Wk 1-6)</td>
<td>11:00 – 13:00</td>
<td>Old Main Bldg K15-229</td>
</tr>
<tr>
<td>Thursday (Wk 7-13)</td>
<td>11:00 – 13:00</td>
<td>Mathews Theatre C D23-303</td>
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</tbody>
</table>
Course Description

Crystallography revision. Theoretical strength; slip; twinning; deformation of single and polycrystals; dislocation multiplication; cross slip; climb; dislocation interactions. Strain hardening; solid solution hardening; age-hardening; dispersion hardening; grain size strengthening; other strengthening mechanisms. High temperature deformation; creep; stress relaxation; effect of strain rate and temperature. Common classes of aluminium and nickel-based and titanium alloys to be taught illustrating some of the principles involved.

Assessment:

<table>
<thead>
<tr>
<th>Assessment Task</th>
<th>Fraction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Online quiz:</strong> You will be required to undertake calculations involving the application of dislocation theory to topics covered in Weeks 1-4.</td>
<td>2.5%</td>
</tr>
<tr>
<td><strong>Due:</strong> Week 5-6*</td>
<td></td>
</tr>
<tr>
<td><strong>Assignment 1:</strong> You will work in groups to answer questions relating to the key concepts discussed in Weeks 1-4.</td>
<td>7.5%</td>
</tr>
<tr>
<td><strong>Due:</strong> Progressive submission from Week 3 to Week 6 (full details given in Week 1).</td>
<td></td>
</tr>
<tr>
<td><strong>Midsession Quiz:</strong> You will solve dislocation and strengthening problems pertaining to information learnt in Weeks 1-6.</td>
<td>40%</td>
</tr>
<tr>
<td><strong>Held:</strong> Week 7, Quiz held in class.</td>
<td></td>
</tr>
<tr>
<td><strong>Assignment 2</strong> You will give a short group class presentation and generate associated background notes on a specific topic relating to Ti, Ni or Al alloys.</td>
<td>10%</td>
</tr>
<tr>
<td><strong>Report Due:</strong> Weeks 11-12</td>
<td></td>
</tr>
<tr>
<td><strong>Final Exam:</strong> The exam will be 2hrs in duration and held in the final exam period. It will cover topics taught in the second half of the course.</td>
<td>40%</td>
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</table>

*The online quiz will be open from 9am, Friday April 1st, until 5pm, Thursday April 14th. You must complete the quiz during this time and will only be allowed one attempt.

**NOTE:** Students who fail to achieve a score of at least 40% for either the mid-session quiz and/or final exam, but achieve a final mark >50% for the course, may still be awarded a UF (Unsatisfactory Fail) for the course.

Please refer to the UNSW guide to grades:

References:

• D. Hull and D.J. Bacon, *Introduction to Dislocations*, 5th Ed., 2011

Learning and teaching philosophy underpinning the course
(based on UNSW Learning Guidelines)

• **Students are actively engaged in the learning process.**
  It is expected that, in addition to attending classes, students read, write, discuss, and are engaged in solving problems on the electronic properties of materials, and in analysis and evaluation of materials' electron-related properties in the context of modern theories of physics.

• **Effective learning is supported by a climate of inquiry where students feel appropriately challenged.**
  Problems involving electron theory are challenging; students will be given assignments that will motivate deep analysis of various physical phenomena in materials science and engineering.

• **Learning is more effective when students’ prior experience and knowledge are recognised and built on.**
  This course is built on prior courses in mathematics, physics and chemistry.

• **Students become more engaged in the learning process if they can see the relevance of their studies to professional and disciplinary contexts**
  Students will be asked to analyse the role of electron theory in understanding various physical phenomena in materials science and how properties such as electrical conduction and magnetism influence the science and engineering of existing and new devices and components.

Course Information

<table>
<thead>
<tr>
<th>Units of credit</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>How the course relates to other course offerings and overall program(s) in the discipline</td>
<td>The course applies theories of dislocation behaviour and strengthening mechanisms to commercial alloys. Mechanical and structural knowledge associated with materials is also called upon. A knowledge of crystallography is assumed.</td>
</tr>
</tbody>
</table>
| Graduate attributes which will be gained through the course* | • Ability to communicate effectively  
• Capacity for creativity and innovation  
• Ability to manage information and documentation  
• Understanding of professional and ethical |
<table>
<thead>
<tr>
<th>responsibilities, and commitment to them</th>
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</thead>
<tbody>
<tr>
<td>• Ability to function effectively as an individual</td>
</tr>
<tr>
<td>• Capacity for lifelong learning and professional development</td>
</tr>
<tr>
<td>• Professional attitudes</td>
</tr>
</tbody>
</table>

**Expected learning outcomes**

In doing this course, you will learn to:

• Relate the role of dislocations and under defects to mechanical behaviour
• Apply strengthening mechanisms to alloy systems and predict behaviour
• Correlate the effect of microstructural development though alloying and heat treatment to mechanical properties

You will also learn to:

• Think critically in decision making and problem-solving
• Communicate with correct terminology
• Conduct online research
• Work effectively in a team to solve problems

**Teaching strategies**

• Core concepts, theories and approaches will be covered in lectures.
• Extensive use will be made of case studies to exemplify theories of dislocation behaviour and strengthening mechanisms in metals.
• Problem design and solution will be learnt through assignments
• Teaching material, including course outline, notes, problems, assignments, case studies and course announcements are available on the Course Moodle website.

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1 Based on the professional attributes given in Engineers Australia National Generic Competency Standards - Stage 1 Competency Standard for Professional Engineers and UNSW Graduate Attributes.

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**Academic honesty and plagiarism**

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**What is Plagiarism?**

Plagiarism is the presentation of the thoughts or work of another as one’s own.* Examples include:

• direct duplication of the thoughts or work of another, including by copying material, ideas or concepts from a book, article, report or other written document (whether published or unpublished), composition, artwork, design, drawing, circuitry, computer program or software, web site, Internet, other electronic resource, or another person’s assignment without appropriate acknowledgement;
• paraphrasing another person’s work with very minor changes keeping the meaning, form and/or progression of ideas of the original;
• piecing together sections of the work of others into a new whole;
• presenting an assessment item as independent work when it has been produced in whole or part in collusion with other people, for example, another student or a tutor; and
• claiming credit for a proportion a work contributed to a group assessment item that is greater than that actually contributed.†

For the purposes of this policy, submitting an assessment item that has already been submitted for academic credit elsewhere may be considered plagiarism.

Knowingly permitting your work to be copied by another student may also be considered to be plagiarism.

Note that an assessment item produced in oral, not written, form, or involving live presentation, may similarly contain plagiarised material.

The inclusion of the thoughts or work of another with attribution appropriate to the academic discipline does not amount to plagiarism.

The Learning Centre website is main repository for resources for staff and students on plagiarism and academic honesty. These resources can be located via:

www.lc.unsw.edu.au/plagiarism

The Learning Centre also provides substantial educational written materials, workshops, and tutorials to aid students, for example, in:

• correct referencing practices;
• paraphrasing, summarising, essay writing, and time management;
• appropriate use of, and attribution for, a range of materials including text, images, formulae and concepts.

Individual assistance is available on request from The Learning Centre.

Students are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting, and the proper referencing of sources in preparing all assessment items.

* Based on that proposed to the University of Newcastle by the St James Ethics Centre. Used with kind permission from the University of Newcastle

† Adapted with kind permission from the University of Melbourne.

Continual course improvement

• Students will be asked to provide evaluative feedback through the UNSW's Course and Teaching Evaluation and Improvement (CATEI) process at the end of the course
• Students are encouraged to address any problems regarding teaching of this course at the annual staff-student meeting
• Student comments on teaching during the session are welcome and will be appreciated
• At times students may be asked to answer a short questionnaire for feedback on the course

Administrative Matters

• Students should attend at least 80% of all classes.
• Students unable to submit assignments on time or attend the mid-session quizzes or final exams on health grounds should make a request for special consideration. Information on this process can be found here
(https://my.unsw.edu.au/student/atoz/SpecialConsideration.html). Medical certificates or other appropriate documents must be included. Students should also advise the lecturer of the situation.

- Assignments/lab reports submitted after the deadline will receive a 10% of maximum grade penalty for every day late, or part thereof.

- Students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course coordinator prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Equity and Diversity Unit (www.studentequity.unsw.edu.au). Early notification is essential to enable any necessary adjustments to be made.

Rules for Exams

Rules governing conduct during exams are given at: https://my.unsw.edu.au/student/academiclife/assessment/examinations/examinationrules.html - Rules for the conduct of examinations

Note that the use of mobile phones or music players in an exam room will constitute Academic Misconduct.